Int J Life Cycle Assess (2013) 18:144–154
DOI 10.1007/s11367-012-0443-6

SOCIETAL LIFE CYCLE ASSESSMENT

Potential hotspots identified by social LCA–Part 2: Reflections on a study of a complex product

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Received: 3 January 2012 / Accepted: 10 May 2012 / Published online: 31 May 2012

Abstract
Purpose We present experiences and reflections from social life cycle assessment (S-LCA) case study, the aim of which was to identify social hotspots, test and evaluate the methodology and propose improvements. This paper discusses the usability and applicability of the methodology used based on our experiences from the study. The main issues considered are whether the gathering of data and other information is feasible and straightforward to perform, whether the method provides added value and relevant results and how these can be presented.
Method We have conducted a generic hotspot assessment on a laptop computer according to the *Guidelines for Social Life Cycle Assessment of Products* (Benoît and Mazijn 2009). The experiences presented were gathered throughout the case study. The supply chain of the laptop was simplified, and we focused on a limited number of materials. The impacts were assessed in relation to the area of protection on human well-being and to affected stakeholders. Social impacts from the actual use of the product were not included. Methodological sheets were used for guidance on inventory indicators and data sources for data collection. Country-specific data were collected and entered into a spreadsheet. The process has been guided by regular meetings in a reference group, composed of representatives of all stakeholder groups.
Results and discussion The data collection process was impaired by a lack of data and low data quality. In order to relate the data collected to the product assessed, each country's share of the activity performed in each phase was determined, and the activity percentage was calculated. In order to consider and relate all the phases in the product system, we used an estimated activity variable due to the lack of data. We developed a new approach to impact assessment. By determining the combination of the most extensive activity, as well as the most negative in the range of possible values for involved countries, we identified the hotspots. The results were not further aggregated in order to promote transparency.
Conclusions We found the S-LCA methodology to be feasible and useful. By handling all relevant issues within one study using a systems perspective on the product life cycle, knowledge can be gained. However, there are still some major challenges. The definition of relevant indicators, data availability, impact pathways, activity variables, results presentation and possible aggregation, the handling of stakeholder context and the restricted assessment of the use phase were identified as major issues to deal with in further studies. Communication, and hence use of the results, is a crucial issue to enable the outcome of a study to result in actions that actually improve human well-being.

Keywords Case study · Generic assessment hotspot · Impact assessment · Laptop computer · S-LCA · Social LCA · Social life cycle assessment

Responsible editor: Thomas Swarr

Preamble We have conducted a case study of S-LCA on a generic laptop computer. The results of the study are presented in two related papers. This second paper (Part 2) discusses the usability and applicability of the methodology proposed in the Guidelines based on our experiences from the study. The first paper (Part 1) (Ekener-Petersen and Finnveden 2012) presents the social hotspots of a generic laptop identified in our study.

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1 Introduction

There are a number of tools available for analysing and assessing social impacts. These include social impact assessment for projects and plans (e.g. Vanclay 2003) and company-related tools and standards (e.g. Social Accountability International 2008, GRI 2007). In addition, the overarching guideline standard ISO 26000, recently finalised in a stakeholder, gender and developing/developed country-balanced global process, constitutes a comprehensive statement on global understanding of the social responsibility issue (ISO 26000 2010).

However, these tools are generally aimed at guiding and supporting the work at an organisational or project level. In order to assess social impacts at product level, other methods are needed. The usefulness of attributing social impacts to products is obvious if the aim of the assessment is to label a product or make a comparison between two products. From a supply chain management perspective, there may also be a reason to work on a product level, especially in the downstream part of the life cycle (Jørgensen et al. 2009).

A life cycle assessment (LCA) approach aims at ensuring that impacts related to a product are considered in a life cycle perspective, i.e. from the production of raw materials, through manufacturing, during use and finally to waste management. This perspective is important to avoid problem shifting, i.e. moving impacts from one part of the life cycle to another or from one type of impact to another (e.g. Baumann and Tillman 2004). This approach is well established for environmental assessments by the methodology for environmental LCA (E-LCA), defined in ISO standards (ISO 14040 2006; ISO 14044 2006).

Until now, as indicated in a study by Jørgensen et al. (2009), there may have been neither will nor possibility in companies to assess social impacts in the product life cycle. Indeed, many companies work with their supply chains in a gradual way, starting with the first tier of suppliers. However, in recent years, we have seen several campaigns by NGOs, demanding responsibility from companies even for the most remote parts of their supply chain. An example is the call for action towards ICT companies regarding the extraction of minerals in conflict areas (Finnwatch and Swedwatch 2010). Thus, there might be reason to reconsider such a position.

In order to enable a life cycle assessment of social impacts on a product level, the social LCA (S-LCA) methodology has been developed based on the E-LCA. It is presented in *Guidelines for Social Life Cycle Assessment of Products* (Benoît and Mazijn 2009; also described in Benoît et al. 2010), hereafter called 'the Guidelines'. The S-LCA methodology allows the user to get a better understanding of the full life cycle of a product in a social and socio-economic perspective and to address important social issues of suppliers many tiers away from the producer. This recent tool is now being discussed, tested and evaluated by different researchers around the world (e.g. Franze and Ciroth 2011; Benoît-Norris et al. 2011a; Macombe et al. 2011; Reitinger et al. 2011). As stated in the Guidelines, there is a need for further development of the method, and case studies are suggested as one good way of facilitating progress in this development.

In this paper, we present experiences and reflections from an S-LCA case study on a laptop computer. The case study was performed based on the methodology in the Guidelines, and its aims were to identify social hotspots in the product system of a laptop and to test and evaluate the methodology and propose improvements. This paper discusses the usability and applicability of the methodology proposed in the Guidelines based on our experiences from the study. The main issues considered are whether the gathering of data and other information is feasible and straightforward to perform, whether the method provides added value and relevant results and how these can be presented. For a more comprehensive description of the case study, see Ekener-Petersen and Finnveden (2012).

2 Method

2.1 General

In S-LCA, the impacts are assessed in relation to an area of protection (AoP). In the Guidelines, this is put as human well-being. The social impacts on the AoP are assessed in connection to affected stakeholders. The Guidelines suggest five different stakeholder categories: worker, local community, society, consumer and value chain actor. It should be noted that the consumer stakeholder is considered only in issues related to the purchase and not during the actual use of the product. The product may have other more far-reaching social impacts during the use phase, but these impacts are not assessed here, in alignment with the Guidelines. The Guidelines also introduce the possibility of using impact categories as a complement to the subcategories, but this was not done in the case study described here.

Each stakeholder is associated with a number of subcategories (Benoît and Mazijn 2009, p. 49), including for example child labour, fair salary, health and safety, local employment, cultural heritage and corruption. Methodological sheets have been prepared in connection to the Guidelines (Benoît-Norris et al. 2011b). These are intended to support S-LCA practitioners by providing more information on subcategories, suggesting inventory indicators and data sources for data collection. Such are proposed for each stakeholder category and its associated subcategories. There may be several indicators and related data sources proposed for each subcategory. The type of data suggested is a mix of qualitative, quantitative and semi-quantitative measurements from many different sources.

There are two different, or consecutive, approaches in the methodology: conducting an assessment on a generic product chain to identify hotspots and/or a specific assessment where the actual product chain for a specific product is assessed. In this case study, we conducted a generic hotspot assessment and thus that is the approach evaluated in this paper.

We have worked systematically according to the Guidelines doing the case study. The process has been guided by regular meetings in one internal and one external reference group. The external reference group was composed so that all stakeholders would be represented. In practice, not all stakeholders took part in the work.

2.2 Defining the product system

The first step is to define the product system. The full supply chain of a laptop is very complex, so it was simplified for this hotspot assessment case study by grouping the unit processes into the phases resource extraction, refining and processing, manufacturing and assembly, marketing and sales, use (i.e. customer relations) and recycling and disposal. Based on the literature (European Commission 2005, Manhart and Grießhammer 2006, Finnwatch and Swedwatch 2010), we decided to focus on a few materials of importance for the laptop. We selected materials that constituted a substantial and distinguishable part of the bill of materials, in combination with those put forward in literature being of importance for social impacts in the supply chain. A selection was required to be able to conduct the study. However, this means increased uncertainty due to the risk that some crucial materials erroneously are left out. Next, we defined which countries in general were involved in the performances in the different phases, limiting the search to the selected materials. Here, we used global statistics on major producing countries which gave us relatively robust information, even though this of course varies over time. Sources were among other sector reports and public statistics (Resolve 2010; EICC/GeSi 2008; US EIA 2011; Classen et al. 2009). For the use as well as the recycling and disposal phase, Swedish practices were assessed as we assumed the laptop to be used in Sweden. However, we took into consideration the flow of illegal e-waste from the countries within the EU to developing countries. Altogether, 32 countries were identified to be involved to different degrees in the product system of the generic laptop as defined here.

2.3 Life cycle inventory

Since this was a generic study, we mainly collected national data, using the data sources suggested in the methodological sheets (Benoît-Norris et al. 2011b), in practice internet addresses with data mostly gathered by governments and international organisations such as ILO and NGOs. Sector-specific data were only found for worker hours at ILO database. For each data source, we analysed and documented the usability of the found data (if found). The collected data were entered into a spreadsheet (Fig. 1). The data collection process was impaired by a lack of data and sometimes low data quality, and the spreadsheet had several blank rows, in particular for stakeholder consumer and value chain actors.

2.4 Defining country significance in each phase of the product system

In order to relate the national data collected to the product assessed, each country's share of the total global activity performed in each phase was determined, and the activity percentage was calculated. For some phases, further calculations had to be made. As resource extraction covers many different metals and other resources, all with different extraction patterns, an assessment was made of the contribution of each resource to the laptop product system. We chose to use the weight of each material in the final laptop as the basis for calculating the phase contribution. In the refining and processing phase, the activity in this phase was assumed to be split, with one-third for metal refining and processing and two-thirds for plastics, as plastic production is seen as having more process steps involved.

Manufacturing and assembly is a very complex phase, and as it was not possible to get reliable quantitative data on the distribution of activity, we used some indicative data from the literature for the estimation of the grouping in this phase. For the remaining phases, Sweden dominated the activity, and no grouping was made.

The result was a ranking of countries regarding their total activity in the respective phases in the product system of the laptop. The rankings were then grouped into four categories—very large activity, large activity, moderate activity and other countries. The three first groups were highlighted. This was used in the impact assessment to identify hotspots.

2.5 Defining the significance of phases in the product system—the activity variable

In order to obtain information about hotspots, considering the whole product system, we need to know the relative magnitude of the activity in each phase. In the Guidelines, it is suggested that this be calculated using an activity variable, i.e. a measure of process activity or scale which can be related to the production of the product, e.g. workers' hours or value added.

Due to a lack of data, we were not able to calculate the activity variable in our case study. Instead, we made some indicative estimations. Two of the estimations put the bulk of activity in the first three phases, with recycling and disposal also notable. The third estimation gave slightly more emphasis to the marketing and sales phase. It should be noted here that the use phase only included customer relations aspects, in

Stakeholder	Subcategory	Indicator	Unit of measure	China	Thailand	US	Saudi Arabia	Germany	Source	Worldmax and min of indicator	Mean and limit for the 25% highest (lowest) values
Worker	Equal opportunities /Discrimination	Women in Labour force	Female working percentage as % of male working percentage	88	83	85	27	87	The World Bank, CPIA	max 100; min 12	56 and 34
	Social Benefits/Social Security	Social Security Expenditure	Spending as % of GDP	5.33	4.74	14.79	0.21	26.17	ILO	max 29.40; min 0.08	7.41 and 14.74
Local community	Access to material resources	Changes in Land Ownership	Publicly owned forests %	68	88	43	98	53	FAO Global Forest Resource Assessm 2010	max 100; min 0	25 and 50
		Levels of Industrial Water Use	Annual freshwater withdrawal by industry, % of	25.7	2.5	46	3	67.9	World Bank, Water Resource Management	max 85; min 0	42.5 and 63.75

Fig. 1 Section of the spreadsheet (adapted for illustrative purposes only). *Pink/dark columns* indicate countries with very large activity in the phase; *blue/medium columns* indicate large activity; and *yellow/light column* indicates moderate activity. The *black circles* illustrate values in the highest quartile of impact globally, indicating severe impacts, and *grey circles* illustrate values in the second highest quartile of impact globally, indicating quite severe impacts

accordance with the methodology in the Guidelines, resulting in a low share of the activity. The three estimations showed similarities, and we calculated a mean. However, this estimation was only used in the discussion of the results due to the great uncertainty.

2.6 Impact assessment

There is an obvious need to present the result from the life cycle inventory (LCI) in a comprehensible way. Producing large tables with huge amounts of data which cannot be related to each other makes interpretation difficult and the usefulness of the results limited. However, clear-cut guidance for impact assessment and aggregation is not provided in the Guidelines. So far, only a few methods have been presented for assessing the results in an S-LCA related to the Guidelines (Franze and Ciroth 2011; Ciroth and Franze 2011; Benoît-Norris et al. 2011a). In this study, we developed a new approach to impact assessment for hotspot identification, as illustrated in Fig. 1.

The way of identifying the hotspots in our approach is to divide the countries into groups depending on their activity, highlighting countries with very large activity, in combination with highlighting the countries with values in the high end of the range of possible negative values for each specific indicator, defining the interval by the world minimum and maximum values of this indicator. Where the strongest vertical and horizontal highlights coincided, we had a hotspot. We also marked all the spots where there were no data available with a dotted red circle to be able to detect any country with low availability of data, thereby escaping a potential identification as a hotspot. The results were not further aggregated, in order to promote transparency.

Some subcategories were assessed by two or three indicators, others by only one. However, all indicators for a subcategory aimed to assess the same impact for that subcategory and should thus only be counted as one impact. In order to avoid certain subcategories prevailing in the final result, we summarised the scores for any subcategory having more than one indicator into one score. In this, we chose the most severe score if the indicators scored differently in one and the same subcategory. This raises some questions, such as did we assess the countries in the same phase on different indicators? Would the result have been different with another choice? This ambiguity introduces some arbitrariness in the assessment; a possibility to choose the most positive of the indicators, thus, maybe concealing some important negative impacts. In order to avoid this, guidance on how to handle different numbers of indicators for subcategories would be helpful.

The full result of the assessment is presented in Ekener-Petersen and Finnveden (2012) in Online Resource 1–6 (see also Fig. 1). It can be displayed in different ways. One is to display the group of countries with the most severe total potential impact in the product system of a laptop. The selection was made on different grounds depending on their activity, where severe total potential impact for a country was determined to be as follows:

- indications of severe impacts on four or more subcategories for countries with very large activity in the product system;
- indications of severe impacts on five or more subcategories for countries with large activity in the product system;
- indications of severe impacts on six or more subcategories for countries with moderate activity in the product system; and
- indications of severe impacts on eight or more subcategories for all other countries in the product system.

Another type of use is the group of subcategories associated with the largest number of severe impacts. Finally, we have a presentation of the real hotspots where very large-activity countries (marked pink/dark) display severe impacts (black circle) (see Fig. 1). We found that these different impact assessment results were valuable to get a more differentiated view of the hotspots in the supply chain. The Democratic Republic of Congo, knows that for problematic extraction of conflict minerals (Finnwatch and Swedwatch 2010), it was not identified as a hotspot but turned up at the list of hot countries.

The question is whether the lack of data lies behind some of the phases displaying very few severe impacts. In our case, the use phase proved to have a limited impact. It was also conducted in only one European country, and only four of the subcategories were considered in this phase. Marketing and sales also contained few severe impacts, even though 11 subcategories were assessed there. Here again, one reason can be the one country performance within Europe. The resource extraction, refining and processing and manufacturing and assembly phases all had many subcategories assessed and many countries involved. Many of the severe impacts were also found here. Finally, in the recycling and disposal phase 11 subcategories were assessed, but a limited number of countries were involved, in which Sweden dominating the activity. Again, few impacts were found. It is thus important to analyse the outcome in different phases and its reasons, so that data availability does not control which phases turn up as most or least problematic.

In order to validate the result further, we made two comparisons: one in relation to the social issues in ICT product supply chains with the most media coverage and one in relation to the expectations in our external reference group.

2.7 Considering the results with respect to the activity variable

The use of the activity variable is intended to refine the results by considering which parts of the product system have the most activity, and thus the largest potential impact on people and the society. As the data on the distribution of activity along the product system in our case study were uncertain, no firm conclusions can be drawn. However, according to the rough estimation we made of the distribution of activity, the most influential phases in the product system investigated were resource extraction, refining and processing and manufacturing and assembly. The recycling and disposal phase also had some influence, whereas the marketing and sales and use phases were relatively insignificant. In this particular assessment, the hotspots, as well as the 'hot' countries, identified before application of the activity variable, all occurred in the three phases with the largest activity. Consequently, the use of the activity variable in this case had no modifying effect, only a reinforcing effect. It should be noted, however, that this is true only if the significant phases were correctly identified, considering the difficulties we faced making this identification.

3 Results and discussion

3.1 Data availability and quality

As mentioned earlier, the data collection met some difficulties. Of 54 proposed indicators, some even with multiple data sources, 25 were invalid or not relevant. Sometimes the data source suggested in the methodological sheets did not contain any relevant data (any longer). The reason could be, for example, that a report, once posted on a website, was no longer accessible. Sometimes data were given per region or per continent. We did not search for additional data outside the sources proposed in the methodological sheets. However, in many cases, that could probably have been successful.

Data quality was another issue of concern. Firstly, as data for all relevant countries were typically not found in the proposed sources, data collection was not complete. With many blanks, there is a risk of not identifying the real hot spots for a specific indicator. Secondly, where we found data, these were sometimes old. For some indicators, the data found at one and the same source originated from different years for different countries. We concluded that choosing the blank would mean that in the case of the true value being a hotspot, this would have been missed out. If the old value had been used and it was more detrimental than the true value (a situation rather likely in light of the general endeavour for continuous improvement), this would give a false indication of a hotspot. However, when further investigating this false hotspot, the improvement achieved would have been revealed. On the other hand, if the old value was better than the true value, this could lead to a missed hotspot. As a consequence, we accepted data from 2000 onwards, as well as datasets from different years. A discussion/guidance of this type in the Guidelines would be a good complement and would help in streamlining choices of this kind.

One major challenge in performing an S-LCA is thus the inventory of data on social and socio-economic issues. In conducting our case study, this was identified as a problem that negatively impacted on the usefulness of the results due to considerable uncertainties. However, as more case studies are conducted and such data are sought, we trust that this will improve over time. New data sources will be identified, and already identified sources will be further developed. In addition, the databases containing data for E-LCA, such as the GaBi database (GaBi Software, www.gabi-software.com), are gradually being complemented with data on worker hours and

social inventory indicators. When this work has advanced, it will be of great help for future data collectors for S-LCA. In March 2011, the Social Hotspot database was launched with data on social conditions in supply chains (www.socialhotspot.org). This database contains data on generic social impacts worldwide on a global scale with geographical precision. The database is still under development but represents a promising tool for better data accessibility in the future.

3.2 Data relevance

A question that arose during data collection was whether the inventory indicators proposed give relevant and sufficient information on the social impacts on a specific subcategory and, ultimately, a relevant description of social hotspots linked to the AoP. The need for analysing and improving impact pathways between indicators and the AoP in S-LCA is also emphasised by Andreas Jørgensen (Jørgensen et al. 2010). It should be noted that the proposed indicators in the methodological sheets are merely examples and do not claim to be either exhaustive or complete (Benoît-Norris et al. 2011b). However, in this case study, we made use of the indicators as they are written in the methodology sheets in order to evaluate them and, if necessary, suggest improvements.

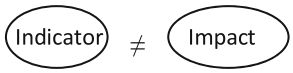
For some indicators, the proposed data source was the *Global Competitiveness Report*, issued by the World Economic Forum. For example, one indicator in the methodological sheets is 'reliability of the police force' from this report, intended to measure the subcategory 'secure living conditions' under the local community stakeholder. In this source, the results are based on a survey of the business sector in the country examined. However, it is not inconceivable that the grounds for judging the reliability of the police services differ from one stakeholder, in this case industry to another, such as the local community or even a group of other stakeholders. A reflection is that the impacts we try to measure in S-LCA are based on values, and these can differ between different stakeholders, such as employers and employees or an NGO and sector organisation. Reitinger et al. (2011) examine the AoP human well-being in a philosophical perspective based on the work by Finnis et al. (1987) as cited in Reitinger et al. (2011). They conclude that this could be helpful in structuring the impact assessment within an S-LCA, as well as for disclosing the normative assumption involved through working with capabilities. We find this approach promising and useful as a support for the practitioner in being transparent about the basic values on which the study is founded. Still, the perspective and aim of the data sources used must be made clear and transparent and considered when interpreting the outcome.

Another issue raised during the use of the indicators was the relevance and completeness of some of these. One example is the indicator 'international migrants as percentage of the population', which is proposed as a measurement for the subcategory 'delocalisation and migration', linked to the local community stakeholder. Our interpretation of what is meant to be measured with this indicator is how well migrant workers (of an organisation included in the product chain of the product under study) are integrated in the local community. The pathway between this performance and the proposed indicator is not self-evident. However, a risk is indicated since a large share of international migrants would involve severe impacts if the reception and treatment of these are unacceptable.

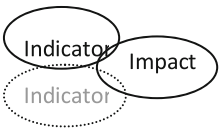
Questioning some of the indicators, we tried to group the potential problems with the indicators into three groups. It should be noted here, however, that the assessment and classification of the type of problems with the indicators was done quite briefly and not in any depth.

1. Indicator is not relevant for impact in an obvious and straightforward way.

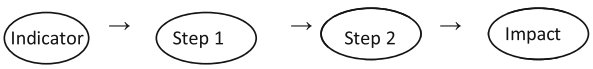
1.1.1.



2. Indicator is relevant for impact, but may not be sufficiently measuring the scope of the impact.



3. Indicator could be relevant for impact, but there are several steps in the pathway which are not clarified, making the evaluation and understanding difficult.



Examples of indicator type 1 can be presence/strengths of laws on construction safety regulations, measured by the indicator 'number of rules and regulations involved when building a warehouse'. This indicator defined for the subcategory 'safe and healthy living conditions' under the local community stakeholder can be interpreted as 'many rules mean a safer warehouse'. However, there may also be other interpretations, such as 'many rules imply a country with a heavy bureaucracy, and maybe even elevated risk of corruption'. It is not evident that the indicator actually measures safe living conditions. We found five indicators affected by this problem. Most of the problematic indicators were of type 2 or 3, scoring 10 indicators for each type. An example of type 2 can be the indicators for the subcategories 'community engagement' and 'access to material resources' related to the local community stakeholder. They seem relevant for measuring the impact but may not

sufficiently capture all aspects of it. A type 3 indicator may be exemplified by 'international migrants as percentage of the population', as discussed earlier. The number of indicators that were found fully workable was 11.

We found also that the relevance of the proposed indicators differed among stakeholder categories. It seems that for the worker stakeholder, the indicators are often easily captured and understood, with a straightforward, and quite often quantitative, relationship to the subcategory. For this stakeholder, 44 % of the indicators were working. This may be a consequence of the worker stakeholder being more assessed previously. There are also international agreements on the expected social conditions for this stakeholder, such as the ILO Conventions (www.ilo.org/ilolex/english/convdisp1.htm). For the local community stakeholder, the impacts are more elusive vis-à-vis the indicators, several of them being qualitative and only 22 % of them were found fully workable. Finally, when it comes to the society, consumer and value chain actor stakeholders, we did not succeed in finding data on enough indicators to be able to draw any conclusions.

Altogether, we found the set of inventory indicators suggested to be helpful and timesaving in data collection. However, they should be further developed and modified to represent the total performance of a subcategory in the best possible manner. There is a risk that, when some indicators seem less relevant or are difficult to interpret, the related subcategories, or even stakeholders, are not considered. This could lead to a subjective choice of subcategories, which is not in line with the purpose of the methodology. It should be noted here that we did not assess the relation between the subcategories and the AoP defined in the Guidelines as human well-being. Further studies are suggested to investigate and improve the relevance of indicators for measuring the subcategories, as well as the AoP.

3.3 Conducting a generic study

A generic study aims at identifying hotspots. Social hotspots can be used for highlighting potential risks of violations and risk to brand reputation, as well as revealing opportunities for social improvements (Benoît-Norris et al. 2011a). When performing a generic study, data on national, regional or sector levels are used.

The usefulness of generic studies with data at this level is sometimes questioned (e.g. Dreyer et al. 2006; Jørgensen et al. 2009). Dreyer et al. (2006) emphasises the importance of making site-specific assessments, as they claim that the performance on social indicators is more closely related to the conduct of specific companies in the supply chain than to the production processes. This could be a valid claim. However, one might as well argue that, even though there will be companies with differing conduct in a country, the country context will have a strong impact on the performance at the company level. The legislation and the cultural and normative values in a country or region will influence the organizational practice. This view is also implicitly supported by Dreyer et al. (2010) in the description of the contextual adjustment, where they state that 'the frequency and severity of violations reveal the topicality of the issue in the actual context, since they are product of norms and customs in the concerned environment'. Moreover, it is claimed also by Macombe et al. (2010), who advocates assessments at sector or industry levels rather than site level. If the purpose of the S-LCA is to provide information in a sector perspective, a generic assessment may even give better information, as it evens out possible extremes at the site level (ibid).

In our view, the suitability of the different approaches is influenced by the aim and the scope of the study. In a conference presentation, Andreas Jørgensen proposed three different uses of S-LCA: 'management S-LCA', for managing internal social issues in the value chain; 'consequential LCA,' for choosing between alternatives; and 'educative S-LCA', for communicating social performance to the market (e.g. labelling) (Macombe et al. 2011). For a management S-LCA, a generic assessment can be a good choice. Getting site-specific information is time-consuming and may limit the possible scope. In order to cover the full life cycle, which is important using a life cycle approach (Weidema 2005), a generic assessment might be necessary. Furthermore, there may be no need to choose. A generic hotspot study may be a first step, facilitating the decision on where to put the emphasis in a following site-specific assessment. Generic and site-specific assessments will therefore most likely have different scopes, aimed at answering different questions.

Conducting a generic study, however, the result will be more credible using more sector data. For example, the rate of child labour in a country may well be concentrated to one or a few sectors, and the sector under assessment might actually use no child labour at all. We believe that in future generic studies, a possibility to use more sector data would be a substantial improvement.

3.4 Use of the activity variable

The Guidelines propose the use of activity variables, such as workers' hours or value. Although workers' hours are probably relevant for the worker stakeholder, it is debatable whether this is the most relevant activity variable for some of the other stakeholders. For example, the local community stakeholder is perhaps more influenced by whether the activity of this particular process represents a large share of the overall economic activity in the community. In this case, turnover, used in the local context, would perhaps be more relevant. Society is a stakeholder on an even more

aggregated level. A relevant activity variable could be of the same type as for local community but on an aggregated level, such as turnover or number of plants as a share of the totality in the society.

Finding data for the activity variables was very difficult. Others have had the same experience (Ciroth and Franze 2011) and chose to not consider the activity variable at all. One alternative option, used in our study, is to make a semi-quantitative or qualitative evaluation of the results based on a rough estimation. This is associated with high uncertainty, however, as regards what the estimation should be based upon. In our study, we made three different estimations, which turned out to be quite similar, and combined them into one final estimate. However, this outcome is subject to vast uncertainties. For instance, the estimations may be similar due to the same (mis)interpretation of reality in all three cases. This approach is hence quite problematic and should only be used as a last resort, making transparency of extra high importance. A way of improving the reliability of an estimated activity variable could be perhaps to involve the stakeholders in a process to make, or refine, the estimations.

It should be noted that the choice and use of different activity variables have the potential to considerably affect the results. Not using an activity variable at all is in fact to say that all processes are of equal importance, which is not a very likely assumption. If more than one activity variable is considered useful for a stakeholder, it may be wise to try several and consider the difference in outcome. However, in our study, the use of the activity variable, based on the rough estimation, did not alter the outcome. It could be interesting to investigate whether there are specific study set-ups, or typical cases, where this is always true in order to avoid the cumbersome process of collecting data for the activity variable. It could also be interesting to look into whether this is the case both for positive and negative impacts.

3.5 Limitation regarding the use phase

The potential social impacts considered in the use phase in the Guidelines are those that result from the relations with and actions from companies involved in the life cycle of the product. During the performance of the case study, business representatives in the reference group asked for a more elaborate assessment of the use phase. A need for this has also been reported by e.g. Jørgensen et al. (2009). In addition, Zamagni et al. (2011) point out that 'the product cannot be analysed in isolation, neglecting the consequences that might arise from its introduction to the market'. Indeed, for a laptop, there may be many positive social impacts during the use phase, such as improved access to information for disadvantaged people. This, as well as some potential negative impacts, could alter the picture of the social impacts from a laptop. In the Guidelines, the assessment of the use phase is pointed out as an area for possible future development (Benoît and Mazijn 2009, p. 78). Work has been done on possible ways to assess the use phase, for example, presented in the Products Sustainability Assessment (PROSA) Guidelines (PROSA 2007), a method for strategic analysis and evaluation of products. It addresses the benefits of a product for the user, defining the utilities as practical utility, symbolic utility and societal utility. This is an interesting enlargement of the utility from just the practical utility, where the symbolic utility may correspond to some of the capabilities discussed in Reitinger et al. (2011). One first and simple possibility to address use phase, as proposed by Dreux-Gerphagnon and Haoues (2011), could be to consider the ethical acceptability of the product in the goal and scope phase, corresponding to considering the societal utility in the PROSA concept. This would at least identify products with clear negative societal utility during the use phase, such as weapons and cigarettes, even if a smoker by definition finds the practical, and maybe symbolic, utility of cigarettes to be positive. Still, further developing the assessment of the use phase is highly called for.

3.6 Aggregation and impact assessment

Classification and characterisation methods, which are used in E-LCA, or similar methods for aggregation of inventory results are not yet developed to any greater extent for S-LCA. One method of aggregation and impact assessment presented is that developed by Andreas Ciroth and Juliane Franze (Franze and Ciroth 2011; Ciroth and Franze 2011). They use a classification system based on the strength of the effect of social impacts, communicated with colour codes in a green–yellow–red scale. The assessments are related to 'performance reference points' described in the Guidelines (Benoît and Mazijn 2009, p. 72). The advantage with this approach is that it represents a clear and intuitive way of communicating the results to interested stakeholders. One drawback may be that one 'green' result may be thought to equal another green result, even though the indicators are considering very different issues. Another drawback may be that the user gets less detailed information on the impacts when results are aggregated and transformed into colour codes.

One other possibility to display the data in a format possible to aggregate would be to construct indices, where positive and negative impacts can be displayed separately by appearing above or below 100. By aggregating positive indices with negative, however, this information becomes lost. We did a limited trial with this approach and, reflecting on the outcome, we concluded that far too much detail was lost in the aggregation process. We found that the complexity of the data in its original format was much more informative and interesting. Therefore, we decided not to aggregate the data but to keep it in its original format, only highlighting the hotspots and other interesting aspects.

It may be tempting to weight the different subcategories and/or indicators to identify what could be perceived as the really serious hotspots. One could easily reason, at a personal level, that one subcategory is more important than the other. However, as the Guidelines are a global tool intended to be used in many different settings and by people with different cultural backgrounds, it is not evident how to find consensus around such a prioritisation. For example, a study by Kölsch (2009) showed that European values on social aspects differ sometimes from those in Brazil. Moreover, prioritisation could differ in the same cultural setting but in different levels of the society (local, regional, national). If prioritisation is still required, one way of doing this could be to use a multi-criteria analysis. Such an approach could be interesting, allowing the decision-makers involved in a specific case to express their values in prioritising among the subcategories. This prioritisation could be based on some international instruments, such as the UN Millennium Development Goals (United Nations Development Program 2000), as international agreements can be said to express the global consensus on prioritising these issues. However, this method is not as clear-cut for generic studies that aim to increase knowledge and where there are no specific decision-makers involved in the process.

So far, the way the result of an assessment is used, the consequences of this use and how this could be affected by the methodology, is not addressed. This issue is also discussed by Jørgensen et al. (2009). Indeed, the AoP human well-being implies that the ultimate goal of using the methodology is to protect or improve social conditions for people globally. If the results are used as grounds for an exit strategy in areas with large negative social impacts, there will be no improvement for the people living there and there may even be a deterioration of social conditions by increased unemployment due to plant closure. The possibilities to address this within the methodology need to be further examined and discussed.

3.7 Placing the result in context

The perspective of the extent to which stakeholders are affected by social improvements, due to differences in context, is still lacking in the methodology. The potential positive, as well as negative, consequence of a change in the social impact is dependent on the starting point and thus the context. Context could be the overall economic situation in the area or the average situation of the workers in the sector or country. For example, reduced unemployment in a country with weak institutions probably has a more beneficial overall impact on human well-being than the same reduction in another country with a higher level of social security (Jørgensen 2010). Some work has been done on impact assessment in which the context has been considered, for example by Dreyer et al. (2010). They have, however, a company perspective and hence put the given context, i. e the external environment determining the risk of negative impacts, in relation to the level of managerial effort requested by the company. Jørgensen (2010) also discusses context but focuses on the validity of S-LCA, as his interest lies mainly in the influences of context on validity through context-related differences in valuations of various aspects of human well-being. Our interest, as explained above, is rather in the differences in potential improvements of the AoP due to context, i.e magnitude of improvement for the relevant stakeholders depending on the starting position. We find it important to consider this perspective in future development of impact assessment methods, as it offers a possibility to move more rapidly towards the goal for S-LCA, namely protection and improvement of human well-being. In addition, consideration of the needs of future generations must be addressed in future research and case studies.

3.8 Reflections on our impact assessment method

In our method, the social impacts in different countries are compared with each other and a relative assessment is made. Assessing, for example, the level of child labour in a country as being, if not good, at least better than in another county, can feel somewhat awkward. Instinctively, any child labour falling under the ILO definition should be considered unacceptable. This relativising of some of the issues, such as child labour, forced labour and other breaches of fundamental human rights, can seem disturbing. However, as the aim of hotspot assessment is to divert resources for amending problems in the supply chain to the most challenging spots, this may be justified here. In the Guidelines, there is a proposal to use performance reference points, these being 'internationally set thresholds or goals or objectives according to conventions and best practices' (Benoît and Mazijn 2009, p. 72). This could be a useful way of avoiding this problem. However, for many of the indicators it could be difficult to find such reference points. In that case, indicators assessed in different ways would probably make it even more complicated to interpret the result.

A potential problem with our method is that it assumes that the interval between world minimum and world maximum for an indicator contains bad values. However, an indicator for which everyone in the world performs well is conceivable, although by looking at the world today, this seems to be more of a theoretical than an actual problem. A possibility in future research could be to develop performance reference points for all the proposed indicators, an effort which could then also address the problem of relativising.

It is easy to focus on the negative impacts and hot spots in a generic hotspot assessment. After all, the potential negative impacts outnumber the positive impacts. In our method, we have not been able to solve that problem satisfactorily. We believe that the assessment of the use phase

demands a different approach. Future research on the use phase, implicitly having mainly a positive social impact, at least in the eye of the user (cp. practical, symbolic and societal benefits in PROSA Guidelines), could usefully be combined with research on methods to identify and display other positive impacts all along the life cycle. In this case, the context is crucial too, as a positive social hotspot should be valued more highly when those in need get a considerable improvement.

3.9 Transparency and interpretation

The issue of transparency is of great importance when it comes to S-LCA. Firstly, many social issues are quite sensitive in themselves, with a clear political undertone. With transparent presentation of results, the study is opened up for criticism and discussions hopefully also leading to increased knowledge. Secondly, in this early stage of development of the methodology, the data accessibility, quality and relevance all leave great room for improvement. This calls for major provision of transparency and great care in interpretation. We argue that the method for impact assessment proposed here, i.e. non-aggregational but in a transparent way putting forward some major findings, allows scope for all stakeholders to clearly see for themselves the data on which our interpretation is based, thus maximising the transparency and the possibility for their own review and evaluation of the results.

4 Conclusions

By performing a social hotspot assessment, much can be learned about the potential social impact associated with the product life cycle. A major benefit is being able to handle all issues relevant to the product life cycle within one study using a systems perspective. However, there are still some major challenges in performing an S-LCA and presenting the results. The definition of relevant indicators, data availability, impact pathways, activity variables, results presentation and possible aggregation, as well as the handling of stakeholder context, was identified here as major issues to be dealt with in further studies. As regards data availability, we believe solutions are underway, whereas issues concerning impact pathways and stakeholder context are important topics to focus on in future development work. Good presentation and communication of the results is also crucial to enable the outcome of a study to result in actions that actually improve human well-being.

The relevance of some indicators was questioned in this paper. Thus, the pathways between the indicators and the assessed performance on social impacts must be further examined and improved. Our case study, identifying sources with no, insufficient or irrelevant data, as well as some indicators with questionable pathways to the impact, can contribute to that development but more work is needed. An open source database, where such experiences and new data sources are added, would perhaps make inventory slightly easier. In our study, we did not assess the impact pathway between the subcategories and the area of protection. This would also be important to fully establish the social impact on human well-being of a product.

The use of activity variables is a difficult task, in particular in a generic study. An area for further research could be to investigate whether there is another way of linking the collected data to the product, as in our understanding it is presently an almost insurmountable task to find data on activity variables. Even if this type of information becomes more easily available in the coming years, there is still the question of which activity variable gives the most relevant distribution of overall impacts, as this may differ among stakeholders. Perhaps a qualitative assessment involving stakeholders and experts would be a feasible way of handling the use of activity variable.

Identifying the context of the relevant stakeholders in different parts of the life cycle may be an even more important task. As the stakeholder context will allow identification of the greatest leverage in the improvement of social conditions, further development of the method is essential.

A drawback of the methodology is the limited assessment of the use phase. We believe that to encourage the business sector to adopt this tool, it needs to be complemented with an analysis of the use phase. This phase would probably be better assessed with a different complementary tool, although it is important to be able to present the result and draw conclusions based on both assessments together.

In order to promote increased learning and to be reliable, the results must be transparent. At the same time, the inventory results need to be summarised somehow in order to communicate them in a feasible way. We argue that too much aggregation at this stage should be avoided, as there are many major uncertainties and data gaps. Interpretation should be facilitated in a way that does not conceal the complexity and the uncertainties in the results.

Our conclusion is that this methodology is feasible and useful, especially when intended for use as a managerial tool, even though it needs more refinement. However, the methodology is too immature and insufficiently robust at present to use it for external comparative purposes such as labelling.

Acknowledgements Financial support from Vinnova and other partners of the Centre for Sustainable Communications at KTH Royal Institute of Technology is gratefully acknowledged. We want to thank the participants in our internal and external reference groups for constructive and interesting discussions and also Professor Göran Finnveden for valuable comments.

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